File 77033

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January 28, 1969

STAT TO:

FROM: [redacted]

SUBJECT: Comment on report on study of coherence effects in image evaluation

The work performed under this contract as represented in the documents given to me represents a workmanlike study of the effects of coherence in a variety of optical instruments. It is my understanding of the history of this contract that originally it was a fairly basic study in looking at the problems associated with coherence effects in image evaluation and in optical instruments. As the program progressed, I think the emphasis was quite rightly changed to be more oriented to the kinds of problems met by the agency, ie. to obtain an answer essentially to the following question "Does coherence play any part in the evaluation and interpretation of images in the various pieces of apparatus used by the agency in the mode of operation used by the trained scientist or engineer?" The report certainly reflects this change in emphasis.

The summary statement essentially contained in the table 1 entitled "Summary of Coherence Effects in Instruments Currently Used" gives a very realistic summary and comment on the conclusions that can be drawn from the studies performed. I would say that the conclusions drawn in this table are correct and well justified. It would appear that a one sentence summary would be that as far as the agency is concerned in the way it uses its instruments at the present time, there are no serious effects due to coherence of illumination of the object.

A number of useful scientific results and an understanding of the whole problem of image formation with partially coherent light has certainly come out of the study. Indeed this is an important area scientifically and technologically and because the summary shows that the agency need not be concerned in the instruments as they use them, this should not be construed to mean that coherence effects are not of some importance in general. In particular, I

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may note a few of the more important results which I feel have come out of this work.

1. The calculation for the two-lens system showing that a simple multiplication of incoherent transfer functions yields erroneous transfer functions for the overall system. This work derives the correct result and shows the difference between the incorrect and the correct final transfer function which are, as can be seen from the curves, quite different.

2. A very nice technique has been worked out for the measurement of coherence when very very small coherence intervals are encountered. This is a modification of a method used by Malik in France.

3. A brief comment is made concerning the effect of phase. An illustration of a phase step is given. Unfortunately this subject is not pursued very far.

4. The nomograph should be of particular value to the working people at the agency since this will allow them to determine in any current use of an instrument whether any problem is likely to be encountered. This they will be able to do without having a detailed understanding of the background and the work that went into arriving at the conclusions.

As I commented earlier, I think this work on the whole is quite thorough and the conclusions valid and realistic. There are, however, one or two areas that have been glossed over a little and may require some further looking at. The first one of these is, of course, the question of phase in the image. The conclusions drawn in this study, as far as I can tell, really state that there are no effects due to the coherence of the radiation for amplitude objects. This statement may not also be true for phase objects. Comment is made at one point in the study that coherence effects could be seen on grain images. This leads me to wonder whether there may in fact be some effect in actual density measurements for instance due to the difference in the coherent and incoherent scattering from the grains. As a guess I would not expect these two considerations to seriously affect the conclusions that have been drawn for the instruments used by the agency. However, of course, they are extremely important in general.

Finally I would like to just comment that this study had some rather specific goals which were attained, but it must not be thought that this study is a complete study of the problems

associated with coherent and partially coherent image formation. With lasers being used more and more as light sources in a variety of photographic situations, the problems associated with this type of image formation are still not well understood and will provide an area for future fruitful research.

I hope that these comments are useful to you in the evaluation of this study.

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